IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application of:	Carlos Dangelo	Confirmation No.:	5164
Serial No.:	10/762,666	Art Unit:	2811
Filed:	January 22, 2004	Examiner:	Nitin, Parekh
For:	*Method and Apparatus for the Use of Self-Assembled Nanowires for the Removal of Heat from Integrated Circuits*	Attorney Docket No.: 062273-5001-US Date: July 17, 2007	

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APPELLANT'S REPLY BRIEF UNDER 37 C.F.R. § 41.41

This brief follows an Examiner's Answer mailed May 17, 2007 and appeals the rejections of claims 28-32 under 35 U.S.C. §103(a) by the United States Patent and Trademark Office in an Office Action dated July 17, 2006. This Reply Brief demonstrates that the Examiner's Answer completely fails to respond to, let alone rebut, Appellant's argument that such rejections cannot be sustained because the references do not enable the claimed invention.

The fee required under 37 C.F.R. § 41.20(b)(2) is estimated to be $250. The Commissioner has been authorized through the electronic filing system to charge any additional fees or credit any overpayment associated with this communication to Deposit Account No. 50-0310 (Docket No.. 62273-5001-US).

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1. THE REAL PARTY IN INTEREST

The real party in interest in this appeal is Nanoconduction, Inc., the assignee of this application.

2. RELATED APPEALS AND INTERFERENCES

Appellant and appellant's legal representative are not aware of any appeals, interferences, or judicial proceedings that will affect directly, will be affected directly by, or will otherwise have a bearing on, the decision in this appeal.

3. STATUS OF THE CLAIMS

The status of the claims is as follows:

Claims canceled: 22-27.

Claims withdrawn from consideration but not canceled: 1-21.

Claims pending: 28-32.

Claims rejected: 28-32.

Claims appealed: 28-32.

4. STATUS OF AMENDMENTS

A request for continued examination (RCE) under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Because this application was eligible for continued examination under 37 CFR 1.114, and the fee was timely paid, the finality of the office action was withdrawn pursuant to 37 CFR 1.114. Applicant's Response to Final Office Action, filed on June 15, 2006, was entered. An action on the RCE followed, which rejected claims 28-32.

A copy of the rejected claims is attached as Appendix A.

5. SUMMARY OF CLAIMED SUBJECT MATTER

As the speed and density of modern integrated circuits increase, the power generated by these chips also increases. (*Application*, p. 1, lines 20-21.) The ability to dissipate the heat being generated by current ICs is becoming a serious limitation in the advance of technology. (*Application*, p. 1, lines 22-24.) While some aspects of this problem can be mitigated by forced convection devices such as fans (and even liquid cooling), the core of the problem is now shifting to the thermal resistances within the chip itself. (*Application*, p. 1, lines 24-26.) This problem is producing high junction temperatures which directly affect chip reliabilities. (*Application*, p. 2, lines 2-3.) The present Application addresses this in-chip heat removal problem.

The Application's claims are directed toward an integrated circuit die having enhanced power dissipation. The integrated circuit die includes one or more cavities in the backside of the die that contain a heat conductive media with a thermal conductivity greater than the bulk thermal conductivity of the substrate. The heat conductive media may include copper (Claim 28) or carbon nanotubes (Claims 29-32).

A. Independent Claim 28: An integrated circuit die having enhanced power dissipation

The integrated circuit die of claim 28 includes a substrate. (*Application*, p. 5, line 2; p. 11, line 3-5; Figure 4, substrate 416.) The substrate has a top surface upon which power generating devices of the integrated circuit die are fabricated. (*Application*, p. 5, lines 2-3; p. 11, line 11; Figure 4, CMOS transistors with gates 408.) The substrate has a backside surface essentially parallel to said top surface. (*Application*, p. 5, lines 3-4; p. 11, line 5; Figure 4, back surface 414.)

The integrated circuit die of claim 28 also includes at least one cavity. (*Application*, p. 5, line 5; p. 11, lines 4-5 and lines 14-17; Figure 4, cavity 412.) The cavity extends from the backside surface a predetermined distance toward the top surface. (*Application*, p. 5, lines 5-6; Figure 4, cavity 412.) The predetermined distance is less than the distance between the top surface and the backside surface. (*Application*, p. 5, lines 6-7; Figure 4, cavity 412.)

The integrated circuit die of claim 28 also includes a heat conductive media contained within the at least one cavity. (*Application*, p. 5, lines 7-8; p. 11, lines 8-9; Figure 4, carbon nanotube filled heat conduction structures 402; Figure 5, carbon nanotubes 502.) The media has a thermal conductivity greater than a bulk thermal conductivity of the substrate, such that heat produced by the power generating devices is transferred to the backside surface via the heat conductive media. (*Application*, p. 5, lines 8-10.) The heat conducting media comprises copper. (*Application*, p. 9, lines 12-13; *Application*, p. 11, lines 8-9.)

B. Independent Claim 29: An integrated circuit die having enhanced power dissipation

The integrated circuit die of claim 29 includes a substrate. (*Application*, p. 5, line 2; p. 11, line 3-5; Figure 4, substrate 416.) The substrate has a top surface upon which power generating devices of the integrated circuit die are fabricated. (*Application*, p. 5, lines 2-3; p. 11, line 11; Figure 4, CMOS transistors with gates 408.) The substrate has a backside surface essentially parallel to said top surface. (*Application*, p. 5, lines 3-4; p. 11, line 5; Figure 4, back surface 414.)

The integrated circuit die of claim 29 also includes at least one cavity. (*Application*, p. 5, line 5; p. 11, lines 4-5 and lines 14-17; Figure 4, cavity 412.) The cavity extends from the backside surface a predetermined distance toward the top surface. (*Application*, p. 5, lines 5-6;

Figure 4, cavity 412.) The predetermined distance is less than the distance between the top surface and the backside surface. (*Application*, p. 5, lines 6-7; Figure 4, cavity 412.)

The integrated circuit die of claim 29 also includes a heat conductive media contained within the at least one cavity. (*Application*, p. 5, lines 7-8; p. 11, lines 8-9; Figure 4, carbon nanotube filled heat conduction structures 402; Figure 5, carbon nanotubes 502.) The media has a thermal conductivity greater than a bulk thermal conductivity of the substrate, such that heat produced by the power generating devices is transferred to the backside surface via the heat conductive media. (*Application*, p. 5, lines 8-10.) The heat conducting media comprises carbon nanotubes. (*Application*, p. 9, lines 11-15; *Application*, p. 11, lines 8-9 and line 15; Figure 4, carbon nanotube filled heat conduction structures 402; Figure 5, carbon nanotubes 502.)

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

In the Office Action mailed July 17, 2006, the Examiner rejected claims 28-32 under 35 U.S.C. 103(a). In particular, the Examiner:

A. Rejected claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Cromwell (US Pat. 5,926,370); and

B. Rejected claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Montgomery et al. (US Pat. Application Pub. 2003/0117770)

7. ARGUMENTS

Appellant maintains all of the arguments made in the Appeal Brief submitted February 14, 2007, which are incorporated by reference herein.

In addition, the Appellant submits that the Examiner's Answer completely fails to respond to, let alone rebut, Appellant's argument that the rejections cannot be sustained because the references do not enable the claimed invention. This point is addressed in detail below.

A. Rejection of claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Cromwell (US Pat. 5,926,370)

The Examiner's Answer responds to the Appellant's arguments concerning Dahl and Cromwell's lack of enablement for claim 28 with a single sentence:

> "However, the references are not necessarily applied for such limitations."
> *Examiner's Answer A(I)*

This single sentence is just a repeat of the same sentence from the Office Action dated July 17, 2006.

This sentence is unclear and unresponsive. By saying that the references are "not necessarily" applied for such limitations, is the Examiner saying that the references could have been used by the Examiner for this purpose, but might have been used for some other unexplained purpose? It is unclear what the Examiner is trying to say here.

In any event, this lack of clarity should not obscure the fact that this single sentence completely fails to address the Appellant's arguments concerning Dahl and Cromwell's lack of enablement. Applicant respectfully suggests that the Examiner's failure to respond (in both the July 17, 2006 Office Action and the Examiner's Answer) to the Applicant's arguments concerning enablement should be taken as a tacit admission that the Applicant's arguments are correct.

Applicant's argument concerning Dahl and Cromwell's lack of enablement of Claim 28 is provided on pages 9-13 of the Appeal Brief. For convenience, a brief summary of this argument is provided here. The aspect of Claim 28 in question is a "cavity," in the back surface of an integrated circuit, that contains "a heat conductive media" comprising "copper." The specific teaching in Dahl upon which the Examiner is relying is paragraph [0121] and Figure 6C of Dahl. This paragraph mentions several alternate diamondoid structures inserted into an integrated circuit as heat conduits. The diamondoid structures mentioned in paragraph [0121]: (1) are conduits in fiber form (either rigid or flexible); (2) are inserted into the chip (1 to 100 fibers or rods are said to be inserted); and (3) are said to "communicate" with thermal vias (not shown in the figures). However, these features are all "wish list" items because there is no teaching in paragraph [0121] or elsewhere in Dahl of: (1) how to make copper (or even diamondoid) conduits in fiber form (either rigid or flexible) or any other form; (2) how to insert from about 1 to 100 copper (or even diamondoid) conduits into the chip; or (3) how copper (or even diamondoid) conduits would "communicate" with thermal vias (not shown). The Examiner does not dispute the lack of these teachings in Dahl. The Examiner apparently fails to understand, however, that the lack of these teachings means that Dahl must necessarily fail to enable one of ordinary skill in the art to make an integrated circuit die with at least one cavity extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising copper, as required by Claim 28. Moreover, Cromwell (which teaches large, macroscopic copper pipes that transport water to achieve cooling) fails to provide the enablement that is missing in Dahl because Cromwell teaches nothing about how to make copper heat conduits in integrated circuit dies. Because Dahl and/or Cromwell fail to enable claim 28, Dahl and Cromwell also fail to make claim 28 obvious.

This "lack of enablement" argument is analogous to the "Dick Tracy 2-Way Wrist Radio" example of non-enablement that is sometimes used in patent law courses. Dick Tracy was a detective in a comic strip that started in 1931. Dick Tracy was famous for his 2-Way Wrist Radio, which was introduced in the comic strip in 1948 (e.g., see **http://en.wikipedia.org/wiki/Dick_Tracy**). This 1948 comic strip drawing of a 2-way wrist radio, however, was not prior art to actual 2-way wrist radios, cell phones, and other mobile communications devices that were developed years later. Why not? Because Dick Tracy's 2-Way Wrist Radio was not an enabling reference. The mere drawing of the 2-way wrist radio in the comic strip did not teach others how to make such a device. Similarly, here the Dahl reference includes a drawing of diamondoid conduits and a wish list of features in paragraph [0121]. But the Dahl reference completely fails to teach others how to make such diamondoid conduits, let alone copper conduits.

B. Rejection of claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Montgomery et al. (US Pat. Application Pub. 2003/0117770)

The Examiner's Answer responds to the Appellant's arguments concerning Dahl and Montgomery's lack of enablement for claims 29-32 with the following sentence:

> "However, as addressed in the response A(I) above, the references are not necessarily applied for such limitations." *Examiner's Answer B(I)*

Once again, this single sentence is just a repeat of the same sentence from the Office Action dated July 17, 2006. The Examiner's Answer goes on to state:

> "Montgomery et al. is not necessarily applied for limitations related to enablement or how to make carbon nanotubes." *Examiner's Answer B(I)*

Both of these sentences are unclear and unresponsive. By saying that the references are "not necessarily" applied for such limitations, is the Examiner saying that the references could

have been used by the Examiner for this purpose, but might have been used for some other unexplained purpose? Once again, it is unclear what the Examiner is trying to say here.

In any event, this lack of clarity should not obscure the fact that these two sentences completely fail to address the Appellant's arguments concerning Dahl and Montgomery's lack of enablement. Applicant respectfully suggests that the Examiner's failure to respond (in both the July 17, 2006 Office Action and the Examiner's Answer) to the Applicant's arguments concerning enablement should be taken as a tacit admission that the Applicant's arguments are correct.

Applicant's argument concerning Dahl and Montgomery's lack of enablement is provided on pages 16-19 of the Appeal Brief. For convenience, a brief summary of this argument is provided here. There is no teaching in paragraph [0121] or elsewhere in Dahl of: (1) how to make carbon nanotube (or even diamondoid) conduits in fiber form (either rigid or flexible) or any other form; (2) how to insert from about 1 to 100 carbon nanotube (or even diamondoid) conduits into the chip; or (3) how carbon nanotube (or even diamondoid) conduits would "communicate" with thermal vias (not shown). The Examiner does not dispute the lack of these teachings in Dahl. The Examiner apparently fails to understand, however, that the lack of these teachings means that Dahl must necessarily fail to enable one of ordinary skill in the art to make an integrated circuit die with at least one cavity extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising carbon nanotubes, as required by Claim 29. Moreover, Montgomery fails to provide the enablement that is missing in Dahl because Montgomery's teachings concern making carbon nanotube structures external to an integrated circuit die that make contact with the die. Montgomery teaches nothing about how to make carbon nanotube

heat conduits inside ("contained within said at least one cavity" within) integrated circuit dies. Because Dahl and/or Montgomery fail to enable claim 29, Dahl and Montgomery also fail to make claim 29 obvious.

The "Dick Tracy 2-Way Wrist Radio" example of non-enablement described above with respect to Claim 28 also applies to Claims 29-32. By analogous reasoning, the Dahl reference completely fails to teach others how to make diamondoid conduits, let alone carbon nanotube conduits.

8. APPENDICES

APPENDIX A provides appealed claims ordered by number.

APPENDIX B provides copies of evidence entered in the record and relied upon.

APPENDIX C provides copies of decisions rendered by the Board or a court in any related proceeding.

CONCLUSION

Based on the arguments presented in the Appeal Brief and in this Reply Brief, Appellant submits that the reasons for the Examiner's rejections under 35 U.S.C. §103(a) cannot be sustained because: (1) the references do not enable the claimed invention, (2) the proposed modification of the primary reference would change its principle of operation, and (3) there is no motivation to combine the references. In view of the foregoing, Appellants respectfully request the reversal of the Examiner's rejections and allowance of the pending claims 28-32.

Respectfully submitted,

Date: July 17, 2007

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APPENDIX A - CLAIMS

CLAIMS CURRENTLY ON APPEAL ORDERED BY NUMBER

28. (Previously presented): An integrated circuit die having enhanced power dissipation, comprising:

a substrate, having a top surface upon which power generating devices of said integrated circuit die are fabricated, said substrate having a backside surface essentially parallel to said top surface;

at least one cavity, extending from said backside surface a predetermined distance toward said top surface, said predetermined distance being less than the distance between said top surface and said backside surface; and

a heat conductive media contained within said at least one cavity, said media having a thermal conductivity greater than a bulk thermal conductivity of said substrate, such that heat produced by said power generating devices is transferred to the backside surface via said heat conductive media, wherein said heat conducting media comprises copper.

29. (Previously presented): An integrated circuit die having enhanced power dissipation, comprising:

a substrate, having a top surface upon which power generating devices of said integrated circuit die are fabricated, said substrate having a backside surface essentially parallel to said top surface;

at least one cavity, extending from said backside surface a predetermined distance toward said top surface, said predetermined distance being less than the distance between said top surface and said backside surface; and

a heat conductive media contained within said at least one cavity, said media having a thermal conductivity greater than a bulk thermal conductivity of said substrate, such that heat produced by said power generating devices is transferred to the backside surface via said heat conductive media, wherein said heat conducting media comprises carbon nanotubes.

30. (Previously presented): An integrated circuit die having enhanced power dissipation as recited in claim 29, wherein said at least one cavity is located directly below at least one power generating device in said substrate.

31. (Original): An integrated circuit die having enhanced power dissipation as recited in claim 30, wherein said at least one power generating device is a transistor having a drain, said at least one cavity being located directly below said drain.

32. (Original): An integrated circuit die having enhanced power dissipation as recited in claim 30, wherein said at least one power generating device is a transistor having a source, said at least one cavity being located directly below said source.

APPENDIX B – EVIDENCE

1. U.S. Patent Application Publication No. 2002/0130407 by Dahl *et al.*, published on September 19, 2002

2. U.S. Patent No. 5,926,370 issued to Cromwell on July 20, 1999

3. U.S. Patent Application Publication No. 2003/0117770 by Montgomery *et al.*, published on June 26, 2003.

4. U.S. Application Serial No. 10/762,666

5. [Second] Office Action dated August 30, 2005.

6. Response to [Second] Office Action dated February 8, 2006.

7. Final Office Action dated April 27, 2006.

8. Response to Final Office Action dated June 15, 2006.

9. Office Action dated July 17, 2006.

APPENDIX C – RELATED PROCEEDINGS

None.